Mechanical Smoker – Dryer for Hard Cured Bloaters

by H. Parker and P. E. Rowe

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Fisheries and Aquatic Services
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Fisheries and Marine Service

Industry Report 113

December 1978

PROTOTYPE MECHANICAL SMOKER-DRYER FOR SMOKING HARD CURED BLOATERS

By

H. Parker and P.E. Rowe

Fisheries and Oceans
Technology Branch
P.O. Box 550
Halifax, Nova Scotia
Canada B3J 2S7

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ABSTRACT

Parker, H. and Rowe, P.E. Prototype Mechanical Smoker-Dryer for Smoking Hard Cured Bloaters (Can. Ind. Rep. Fish. Aquat. Sci. 113).

Bloaters, also known as "red herrings", "salmon herring" or "hard smoked herring"; are salted, dried, smoked, round herring. (See Appendix B for a brief history of the bloater). Bloaters have been produced in the Maritime Provinces for over 200 years. Eastern Canada exported approximately 8.7 million pounds of bloaters in 1977 worth about 3.6 million dollars. (See Appendix A, Table 1 for Canadian Exports of Herring Bloaters).

The bloaters take from 6-8 weeks to cure during which time there may be a considerable loss of product due to poor drying weather which results in insufficient drying and/or spoilage by insects. Bloater production is a laborious process from the start to the finished product.

In 1977, following research into the possibility of improved product quality, a prototype mechanical smoker-dryer was designed to produce hard cured bloaters.

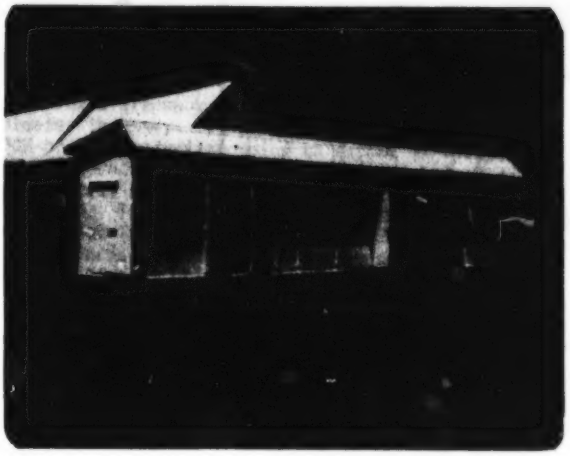
RESUME

Les craquelots, aussi connus sous les noms de harengs rouges ou de harengs fortement fumés, sont salés, séchés et fumés entiers (voir le bref historique en annexe B). Dans les Maritimes, on prépare ce produit depuis 200 ans. En 1977, l'Est du Canada en a exporté environ 8,7 millions de livres, soit une valeur de 3,6 millions de dollars approximativement (exportations Canadiennes de craquelots: tableau 1, annexe A).

Durant les 6 à 8 semaines de traitement, les pertes peuvent être considérables en raison des mauvaises conditions qui rendent le séchage insuffisant ou qui favorisent l'apparition d'insectes. Il s'agit d'un procédé laborieux du début à la fin.

En 1977, à la suite de recherches en vue d'améliorer la qualité du produit, un prototype mécanique de fumoir-séchoir a été conçu pour produire des craquelots séchés à coeur.

PROTOTYPE MECHANICAL SMOKER-DRYER FOR SMOKING HARD CURED BLOATERS



INTRODUCTION

A prototype mechanical smoker-dryer for smoking hard cured bloaters was designed by the Technology Branch (Halifax) of Fisheries and Oceans Canada and installed at Brunswick Seafoods Ltd., Lower Cape Bald (near Shediac) New Brunswick. The design by R.H. Davis, C.A. Passey and K. Rodman, was a modification of the Atlantic Fisheries Experimental Station salt fish dryer (Wood and Power 1945)[1] that operated at an air velocity of approximately 400 F.P.M. and had a capacity of 5000 pounds of fish. The dryer was tunnel-shaped, thus the word "tunnel" was used to describe it.

Compared to conventional bloater smokehouses, the tunnel was intended to:

1. reduce the loading and unloading labour
2. reduce the smoking/drying time from 6-8 weeks to 2 weeks by controlling the drying conditions
3. reduce or eliminate contamination by flies; and
4. increase the quality of the product by better quality control. The design was intended to determine the economic feasibility of producing hard cured bloaters utilizing a mechanical smoker-dryer with a reasonably steady supply of raw material compared to the conventional smokehouse operation based on 1 or 2 "batches" a year.

The results of 5 trial runs with the tunnel indicated that a good-quality contamination-free product could be produced in 17 days with less labour than would be required with a conventional bloater smokehouse. Data and experience gained from the tests, should be of aid in the design of any future smoker-dryer. (See Appendix A, Table 2. Bloater Processing Estimated Costs and Revenue).

1. A.L. Wood, Description and Specifications for the A.F.E.S. Tunnel Type Smokehouse (Revised). Fisheries Research Board of Canada, Circular No. 35, Box 429, Halifax, N.S. 1947.

General Description

The tunnel was a prefabricated sectional steel cabinet. The walls and ceiling were insulated with 3" thick urethane foam insulation, encased in 24 gauge white enamelled steel. The cabinet, which was 34' long, 7.5' wide and 9.5' high overall, was erected on a floor consisting of a 5" thick concrete slab on crushed stone. The roof was sloped to the back which provided a 10" canopy over the front and end doors. A 1.5' high air duct extended the full length and width of the cabinet between the ceiling and the top of the doors. There were 5 double doors on the front to facilitate loading and unloading of the tunnel.

A small room, 15' long, 7.5' wide, and 9.5' high at the end of the cabinet (tunnel) was constructed of plywood and sheathed with sheet metal on the outside. It housed the furnace, smoker, and electric controls. The total length of the structure was 49'.

The electrical panel included switches for an exhaust fan, damper motor, furnace, smoker, sawdust burner and a circulating fan.

Total cost of the erected tunnel was $42,148.

Dryer Controls

The controls were designed to;

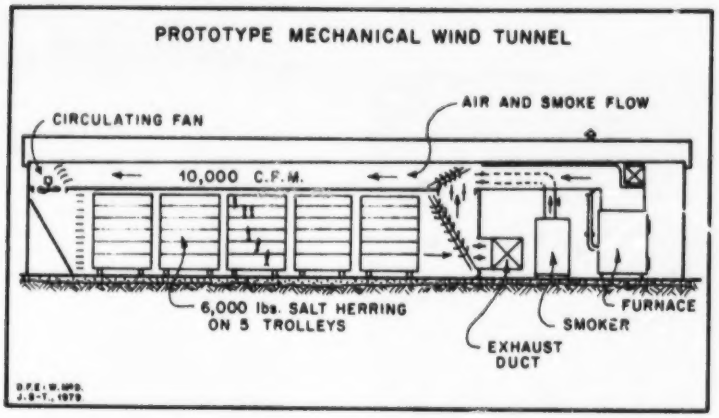
1. maintain a constant flow of high velocity air in the tunnel. The velocity of the air over the fish, prevented the down-draft of cold wet air which sometimes occurs in the conventional natural draft smokehouse and may not permit uniform smoking. The air inlet screens and the high velocity of the air in the tunnel also prevented contamination from insects;
2. heat make-up air to 75°F;
3. add a constant density of smoking air to the tunnel for a variable time;
4. limit the moisture content of the air to 65% relative humidity or less depending on ambient conditions (there was no dehumidification).

With the fish in the tunnel and the circulating fan operating, the air circulating over the fish picks up moisture and is cooled by evaporative cooling and leakage. Wet and dry bulb sensors located below the circulating fan sense the air conditions going to the fish. (See Appendix C for Operation of Funnel). When the air to the fish is too cool (below the set point), the furnace burner and fan are turned on and operate until the air reaches a temperature just above the set point, at which time the furnace burner shuts off. (See Appendix D for Tunnel Equipment).

The recycle damper closes when the air going to the fish reaches 65% relative humidity, which in turn causes the inlet and outlet dampers to open.

TRIALS AND RESULTS

Five trials were completed in the tunnel. (See Appendix E, Operating Trials). The first



trial commenced June 15, 1977 and and the last trial terminated July 13, 1978. The trials proved a good quality product could be produced in 17 days. The first four trials produced hard cured bloaters that were shipped to the West Indies. The moisture and fat contents were higher than the optimum, thus, the bloaters were not as firm as the traditional hard cured bloaters. (See Appendix A, Table 3 for Bloater Analysis Trial 4). Generally, the bloaters had good taste, colour, odour, firmness and dryness. Generally, there was insufficient smoke penetration with the exception of Trial 5 which produced an excellent mild cured bloater. The results of the trials indicated that acceptable smoke penetration could be obtained by initially providing smoke with minimal drying. Rapid drying initially appears to slow down smoke penetration.

The labour required for loading and unloading the tunnel was minimal compared to a conventional bloater house. The labour required for loading and unloading a 63 hogshead smokehouse is 1.9 man-hour/hogshead or 120 manhour/batch. The equivalent labour in the tunnel smokehouse is about one half this amount.

The product yield was excellent with only minor losses due to fish falling off the rods inside the tunnel. The process control was better than in the conventional bloater smokehouse because most of the work involved in the fish processing was mechanical after the fish entered the tunnel. In the conventional smokehouses the fish are moved manually to different positions which can result in a significant loss of fish. This loss is eliminated in the tunnel smokehouse.

Due to the higher air flow and improved air conditions, there was an increase in output and air increase in yield due to better process control.

Problems with Tunnel Design

The tunnel was not designed as a closed system, so to a large degree was dependent upon outside atmospheric conditions. Although humid air was heated, thus lowering the relative humidity, very little drying occured on rainy humid days when the dew point was high.

To make the tunnel a closed system, a dehymidifying system would have to be installed. The addition of a heat pump or refrigeration coils was not economically feasible. "Dehumidification of the intake air has been tried on large Torry kilns but again, the cost of the plant and the cost of operation was uneconomical in comparison to the reduction of overall smoking time."[2]

The A.F.O.S. smoke generator was used in preference to friction smoking since it was felt that friction smoke would not provide the desired taste and flavour.

There was a design problem under certain air conditions. When the air circulating in the tunnel was too moist, the wet bulb sensor triggered the exhaust and inlet dampers to open and the circulating damper to close and air was ejected. This arrangement worked well when the air was hot. But heat could not be added to the system without drawing in outside air. Both exhaust and inlet dampers cannot be open at the same time as the circulating damper.

With air circulating through the tunnel, the circulating damper is open and the exhaust and inlet dampers are closed. If the temperature of the circulating air drops below the dry bulb set point, the furnace turns on and trys to inject hot air into the system. The hot air cannot enter because the inlet damper will not open while the circulating damper is open. The hot air backs up into the furnace and the furnace shuts off. This situation was partially corrected by adjusting the inlet damper, so it never completely closed.

RECOMMENDATIONS FOR IMPROVED TUNNEL DESIGN

1. The installation of an oil fired hot water furnace to replace the existing hot air furnace. This would permit heat to be added without adding outside air.

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2. J. Horne, Industrial Liaison Officer, "Ministry of Agriculture, Fisheries and Food", Torry Research Station, P.O. Box 31, 135 Abby Road, Aberdeen, Scotland, October 25, 1976. (letter).

2. The racks should be modified to prevent the rods from falling off.

3. The sensors for the dampers should be changed to permit a faster response to changing air conditions.

CONCLUSION

There are many beneficial aspects to the bloater industry. It is export oriented with over 90% of the production going to export markets. Bloater processing has become a way of life and an integral part of the economy of the regions involved. The industry supplies short term employment for housewives and fishermen. In the Shediac area, the bloater industry supports 3 or 4 industries within a 200 mile radius.

However, the bloater industry is in a precarious state. The basic problem is the unpredictable supply of herring and high prices. The price of herring in 1975 was about $45/ton. In December 1978, the price of herring was $300/ton. With the high operational and production costs, bloaters which are considered low cost items are now being produced at high cost prices.

The trials have demonstrated that the tunnel is capable of producing a good quality bloater. With a few modifications, the efficiency of the tunnel can be greatly increased. However, unless a steady supply of fresh herring is maintained for a more continuous process and alternative markets are found for the higher prices of the bloaters, the building of larger more efficient tunnels for hard cured bloaters is not advisable at this time.

If there are improvements in smokehouses and temperature controlled facilities exist, a good quality mild cured bloater for European markets could be produced. Some mild cured bloaters are now being produced for European markets.

The tunnel could now be used for further trials, perhaps producing a different type of smoked product either hot or cold. The tunnel would also be advantageous for producing small orders of bloaters (50 boxes). It would also be used just as a dryer for such products as salted groundfish. If the dryer was operated continuously, this would provide continuous employment for a few people, instead of a large number of people for a short time. (See Appendix F for Possible Improvements for Bloater Processing).

In spite of the many problems associated with bloater production, the inadequate supply of good quality fish, escalating production and material costs and the high price of the finished product, there still is a constant demand for bloaters. (See Appendix G for Problems Associated with the Bloater Industry). For further information please contact Mr. Paul Rowe, Fisheries and Oceans Canada, Fisheries Development Branch, Engineering Services Division, Box 550, Halifax, N.S. B3J 2S7; telephone (902) 426-2097.

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APPENDIX A: Table 1

Canadian Exports of Herring Bloaters
(Quantity (Q) in million pounds, Value (V) in $000)

	1971		1972		1973		1974		1975		1976		1977		1978	
	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V
Surinam	--	--	-	-	--	20	-	-	-	-	-	-	.07	27		
Guyana	0.1	26	--	3	-	-	-	-	-	-	-	-	-	-		
Bahamas	--	2	--	2	--	1	-	-	-	-	-	-	-	-		
Bermuda	-	-	--	1	-	-	-	-	-	-	-	-	-	-		
Barbados	--	19	--	16	0.1	49	0.1	61	0.1	50	.05	22	.09	40		
Norway	--	2	-	-	-	-	-	-	-	-	-	-	-	-		
Jamaica	0.8	196	0.4	106	0.3	103	0.5	179	0.3	144	.2	79	.3	112		
Leeward-Windward Is.	0.6	140	0.5	127	0.2	49	0.3	105	0.2	89	.2	85	.3	132		
Trinidad-Tobago	0.4	100	0.4	.114	0.3	87	0.5	214	0.4	190	.4	171	.4	161		
Costa-Rica	--	5	-		-	-	-	-	-	-	-	-	-	-		
Dominican, Rep.	1.7	451	2.6	779	1.8	604	3.4	1498	4.6	2067	4.9	2019	5.8	2448		
Haiti	0.6	133	0.7	129	0.7	197	0.6	178	0.7	276	.8	316	1.2	473		
Neth. Antilles	--	2	-	-	-	-	-	-	-	-	-	-	-	-		
Puerto Rico	0.5	116	0.4	80	0.3	97	0.4	183	0.6	248	.4	158	.1	67		
United States	0.1	24	0.2	76	0.2	69	0.2	82	0.3	145	.3	146	.4	185		
Hong Kong											.02	7				
St. Pierre-Mig																
West Germany	.002															
TOTAL	4.9	1215	5.4	1433	3.9	1276	6.0	2500	7.3	3209	7.3	3002	8.7	3645		
V/Q = ¢/lb.	24.6		26.5		32.7		41.7		50		48.3		49		61.1	
No. Boxes	272,222		300,000		216,667		333,333		405,556		405,556		483,333			
$/Box	4.46		4.78		5.89		7.50		9.00		8.70		8.75		11.00	

APPENDIX A: Table 2

Bloater Processing

"Estimated Costs & Revenues"

	January/78 Traditional Smokehouse (7000 Boxes)			January/78 Mechanical Tunnel			July/78 Mechanical Tunnel		
Raw material	$/Box	¢/lb.	% (of selling price)	$/Box	¢/lb.	%	$/Box	c/lb.	%
Finished Product	$4.63	25.7	42.	4.75	26.4	43	5.58	31.0	50
Salt	$ .35	1.9	3.	0.30	1.7	3	0.74	4.1	7
Fuel: Wood & Karosene	$ .46	2.5	4.	.08	.4		.16	.9	
Furnace Oil				.55	3.1		.07	.4	
Electricity				.15	0.8		.10	.6	
Fuel Total	.46	2.5	4.	.78	4.3	7.0	0.33	1.8	3
Box Costs	.91	5.1	6.	.91	5.1	6	.91	5.1	8
Labor: (Total)	$2.06	11.4	18.7	.96	5.3	9	0.51	2.8	4
Direct Costs: [Material + Labor]	8.41	46.7	76.4	7.79	43.3	70	8.16	45.3	72
Overhead: [assuming 20% D. Costs]	1.68	9.3	15.2	1.55	8.6	14	1.63	9.1	15
Total Costs	$10.09	56.0	91.7	9.35	52.0	85	9.79	55.4	87
Sale Price	$11.00	61.1		11.00	61.1		11.25	62.5	
Profit	$ 0.91	5.1	8.3	1.64	9.2	15	1.46	8.1	13

APPENDIX A: Table 3

Bloater Analysis - Trial 4

Date	Sample	% Moisture	% Ash	% Lipid	% Salt
Jan. 13	BLA1	68.7	6.30	3.04	5.33
" "	BLA2	68.0	7.00	-	5.23
" "	BLB1	67.9	6.57	6.20	5.08
" "	BLB2	68.7	6.15	5.95	5.12
" "	BLC1	69.4	8.75	2.70	7.66
" "	BLC2	68.9	8.80	3.33	7.26
" 19	1BLA1	58.3	7.14	7.34	8.88
" "	1BLA2	-	-	8.01	6.96
" "	1BLB1	52.3	9.14	10.12	7.78
" "	1BLB2	52.2	9.96	9.85	7.74
" "	1BLC1	47.6	11.40	7.70	7.42
" "	1BLC2	47.6	11.60	8.36	8.63
" 23	2BLA1	40.4	11.35	10.19	9.21
" "	2BLA2	40.6	12.15	8.46	8.63
" 25	3BLA1	32.4	15.4	8.36	11.02
" "	3BLA2	32.2	15.0	-	11.23
" "	3BLB1	34.0	15.6	10.95	11.33
" "	3BLB2	35.0	14.6	9.25	11.08
" "	3BLC1	37.2	12.0	9.04	9.58
" "	3BLC2	32.2	12.0	9.38	9.25
Feb. 1	4BLA1	38.6	9.4	14.51	7.47
" "	4BLA2	41.4	8.6	-	-
" "	4BLB1	37.4	11.2	12.67	8.59
" "	4BLB2	37.8	11.0	13.68	9.34
" "	4BLC1	36.4	12.2	13.34	10.03
" "	4BLC2	37.4	11.3	11.40	8.61
FINAL		38.2	10.7	13.3	8.6
OPTIMUM		32.38	-	10.13	14.17

APPENDIX B

Brief History of the Bloater

Bloaters were prepared as early as the sixteenth century in Great Britain. They became a staple food and were one of the few items of diet available to people during Lent until fresh foods appeared again. The name bloater is supposedly derived from the rounded or bloated appearance acquired during the process of curing.

In 1795 a Scottish fisherman started smoking herring in Digby, Nova Scotia, the first town on the continent to become noted for its smoked herring. His fish became widely distributed and became known as "Digby Chicks". Soon the production of smoked herring spread along the coast of Maine and in 1859, Boston was the first city in the United States to engage in the preparation of bloaters.

How Bloaters are Produced

The following is a brief description of the traditional method of preparing bloaters which has persisted to the present day.

Supply

Bloaters are produced from fresh round herring, i.e. gut in, head on. The fresh herring is obtained from the fishermen and is graded for size and the scales removed. The herring is usually caught by seiners, trawlers and gill netters.

Brining

The herring are trucked to the bloater processors in boxes or barrels to avoid excessive weight while in transit and brined in tanks in a tankhouse for approximately two days in a brine that may vary from 65 to 100% depending on the producer. The concentration of the brine must be maintained by adding salt periodically. Uniform salting is important and is accomplished by keeping the fish loose and by "penching" (stirred by hand), once or twice a day. Sometimes dry salting is used as an alternate method.

After the fish are "struck" (thoroughly brined) over 36 to 48 hours, they are removed and sometimes soaked for a brief period in fresh water or sea water before smoking. A method used by some briners to determine when the brined fish are ready is, to squeeze the gills and if no blood oozes out, the herring have been brined sufficiently.

Salting firms the fish by removal of moisture and by partial denaturation of the protein; salt inhibits the growth of bacteria and it also imparts a flavour to the fish.

Hanging

After brining, the fish are hung on iron or wooden rods pointed at one end. The rods should be 1/2" - 3/4" in diameter, strong enough to hold 18 - 20 herring. The pointed end of the rod is forced under the gill and out the mouth. The herring hangs vertically with the head section twisted horizontally which restricts the herring from shifting on the rod. There is a slight space between each herring and all herring face in the same direction.

Drying

Drying in the open air is the most ancient and important method of preserving food. After the fish are loaded, drying fires are lit, green fish are always located closest to the fires and drier fish are moved closer to the top of the smokehouse. Hardwood logs are placed four or five inches apart and a small fire is started. When the fish are dry, this fire is smothered with hardwood sawdust and allowed to smother. Drying usually takes 4 days.

Drying serves two purposes. It removes additional moisture to such an extent that decomposition by both bacterial putrefaction and autolysis is sufficiently inhibited to insure reasonable keeping qualities, and drying causes the formation of a pellicle or crust which aids in the absorption of smoke.

Smoking

Bloaters are cold smoked, that is, the fish are cured in an atmosphere below 85°F (29.4°C). The fish are smoked for a period of 6-8 weeks, sometimes longer depending on weather conditions. The primary purpose of smoking is to impart flavour and color. Phenolic compounds of the wood creosols have a slight preservation effect but little preservation is afforded by the smoking process.

There are 4 factors to be controlled in smoking; the temperature must not exceed 80-85°F or cooking will occur; the recommended relative humidity is between 60-66%; a relative humidity over 70% results in air not absorbing appreciable moisture from the fish; below 60% absorption is too rapid and extreme, hardening results (i.e. case hardening); the rate of air flow and its distribution around and over the fish must be uniform and the density of smoke should be uniform throughout the process. To obtain smoke uniformity, many small fires are lit rather than a few large fires and their position is changed every day.

Ventilation

While the fish are drying, it is usual to have the door opened slightly, the windows at the back of the house open and the windows on the roof open. When the smoke fires are lit, the door and lower windows are usually closed and the windows on the roof opened on the leeward side. The manipulation of the door and windows regulate the amount of heat in the house, and this depends upon the weather conditions and the velocity of the wind. As a rule of thumb, the fish temperature should not exceed 70°F.

Packing

After smoking, the bloaters are unloaded from the smokehouse and packed in 18 pound wooden boxes net weight and shipped to the West Indies.

Bloater Export

Bloaters are produced in Canada mainly for export to the West Indies, particularly the Dominican Republic where consumption is confined mainly to the smaller rural outlets. Bloaters provide a relatively low cost source of protein to lower income groups who are composed mainly of farm labourers. There is also a small domestic market in Nova Scotia and New Brunswick.

Cooking Methods

Bloaters are cooked and consumed in different ways. In the West Indies, bloaters, especially during harvest time, are a convenient and inexpensive source of food for the plantation workers. Bloaters can be eaten as the main meal. For example, in Haiti, those in the lower income class barbecue the fish to "cook" it slightly before eating it.

While the affluent mince and fry it with eggs. Bloaters may also be barbecued with bananas and eaten together with rice. They may also be eaten for breakfast. First the skin is removed, then the fish is cleaned, diced and mixed with peppers or tomato sauce. It is reported that bloaters are wrapped in newspaper, put in the fire and when the paper burns off, the bloaters are ready to be eaten. Bloaters are also consumed locally in Canada and the United States. They are usually eaten as a snack with beer or prepared by gutting, then frying and eaten with vegetables.

Bloater Producers

Bloaters are mainly produced by fishermen, most of whom rely on other sources of income, such as canning, tobacco farming, the pickling of fish and lobster fishing . Income from other sources may range from 10 to 80% of a bloater producers total income. Most processors are single ownerships.

The bloater production industry is comprised of approximately 63 producers, about 40 are located in the Shediac area of New Brunswick - (29 years ago there were 80 producers in the Shediac area alone). Approximately 30% of the total number of producers are members of the United Maritime Fishermen.

Bloater producers may range in age from early twenties to late sixties. There are approximately 10 producers on Grand Manan Island and 13 on the Magdelen Islands. The average processor operates his plant for a period of 12 weeks, usually from May to July.

Location of Producers

Bloaters are produced along the Canadian Atlantic East Coast particularly along the North West coast of New Brunswick, mainly in the Shediac area. Bloaters are also produced on Grand Manan Island, New Brunswick, the Magdelan Islands in Quebec and in Church Point, Nova Scotia. A mild cured bloater is also produced in Europe notably in Great Britain, the Netherlands and Norway.

Traditional - Smokehouses

Bloaters are produced in smokehouses which have evolved very little since the Middle Ages. Smokehouses are large barn-like structures usually made of wood. Most smokehouses are old, some actually converted barns. In 1973 68% of the smokehouses were 20 years old or less, 48% of the tankhouses were over 20 years old.

There are no set dimensions for bloater houses, thus are constructed in different sizes. The overall length of a typical smokehouse is approximately 75' long, 22' wide and 27' high. The houses are divided into 3 sections. Each section is divided into 9 bays. The racks in each bay are vertically spaced at 12 inches.

Salted herring are placed on wooden sticks on the racks and the sticks are separated horizontally at about 3 to 4". A single section holds 63 hogsheads of round salt herring. Several large sliding doors are located in the upper wall which may be opened or closed depending on weather conditions. Vents are located in the peak of the roof.

The holding capacity varies in smokehouses, usually 7000 boxes are produced from a full house i.e. (63 tons of bloaters).

Period of Production

Bloaters are produced mainly in the spring, April, May and early June when there is an abundance of low fat herring. In the fall of 1970, 6 bloater producers produced approximately 5000 boxes of bloaters. This was unusual as bloater production was previously restricted to the spring herring only.

In the past 5 or 6 years there has been a trend to produce bloaters in the fall and winter or whenever a low fat herring was available. (The optimum fat content of fresh herring for hard cured bloater production is 13% or less). Some bloater houses operate the year round but usually slow down or discontinue operations in the summer due to unsuitable fish mainly high fat content and the presence of excessive milt or roe and adverse weather conditions. Some producers may put through 4 or 5 batches per year.

APPENDIX C

Operation of Tunnel

1. Place fish in the tunnel, turn on the circulating fan.
2. Set furnace thermostat (dry bulb) to give desired air temperature entering the fish.
3. Check circular chart recorder for air temperature entering the fish.
4. Depending on outside temperature, turn furnace on. The furnace intake fan may be left operating continuously if desired, such as in the summer during warm weather.
5. Turn on the power to the damper motor.

6. Turn on exhaust fan. The fan may be used when drying without smoking or when smoking.
7. Fill wet bulb water bottle and check periodically to ensure supply of water.
8. Damper thermostat (wet bulb) should have proportioning range and set point adjusted so that the air going to the fish is less than 65% relative humidity.
9. Fill the smoke generator with damp sawdust, start the fire, adjust burner control levers and turn on the power.

APPENDIX D

1. Three dampers: for air mixing: with axles; multi-blade.

   2 - 20" high x 24" wide

   1 - 32" high x 24" wide

2. Smoke generator: The smoke generator used was a typical automatic smoke producer. It was constructed of heavy mild steel with an integral fuel hopper with a capacity of approximately 100 lbs sawdust and an operating time of approximately 3 hours on full output. There was a rotary metering valve incorporated in the base of the hopper with 4 fuel speeds. The fire box incorporates a primary air fan providing combustion air to the underside of the grate. The unit incorporates a water circulating heat exchanger above the fire bed level which keeps the volatiles in the fuel below combustion temperature and any tendency to flare is eliminated. Lighting and keeping the hopper full requires manual labour.
3. Circulating Fan: 30" propeller fan, 10,000 C.F.M. @ 1/2" S.P., 3 H.P.
4. Furnace: wood/oil burner 135,000 B.T.U./hr., 1450 C.F.M. (200 gal. fuel tank located outside the tunnel).
5. Damper Temperature Controls: Proportional copper capillary, 0 to 100°F. range 24 V; 135 ohm, with bulb holder and bracket.
6. Damper Motor: Proportional, 24 V. with balance relay, reversing.
7. Damper Linkages: Extend from external mounted motor to three dampers.
8. Aluminum Racks: 5 aluminum welded racks. The racks were 7'0" high x 7' 1/2" long x 4'0" wide.
9. 1080. Aluminum rods for hanging the fish on the racks.
10. Two steel turning vanes for air distribution. Each vane is approximately 7'0" high, 7' 1/2" long.
11. Baffle made of plywood, installed in the front section, before the turning vanes and behind the circulating fan.
12. Wet and Dry Bulb Thermal Systems and Accessories. The wet and dry bulbs were capillary enclosed in common armour and require a flow of air at least 15 feet per second. The wet bulb controls the damper motor and the dry bulb controls the furnace controls.

Accessory Equipment

1. Circular Chart Recorder with a gas-activated thermal system. It showed what the measured variable is at any moment and records it continuously along the time markings.
2. 24 Point Strip Chart Recorder.

APPENDIX E

Operating Trials

Trial 1

The first trial commenced on June 15th and terminated July 1st 1977 (16 days). Herring and alewives were strung on wooden sticks and aluminum rods. The salted herring was tested to be 14% fat; 61% moisture and 8% salt. The herring were smoked for 16 days and the alewives were taken out sooner because they dried faster. The final product was good and 12 boxes of alewives were shipped to the Dominican Republic; 129 boxes were shipped to Haiti; and 150 boxes of hard cured bloaters were shipped to Haiti. The recycle damper was not installed and the recycled air was diverted by means of a sheet of plywood.

During the trial, tests were made which showed more air passed through the fish with the recycle blocked off than with it left open (air flow increased from 600 to 3600 C.F.M.). An exhaust fan was added to increase the air flow through the fish (with the recycle open) from 600 to 1800 C.F.M. and a small vent was added in the furnace room.

Trial 2

The second trial commenced August 26 and terminated September 26, 1977 (31 days). The tunnel was loaded with 12,500 pounds of salt herring; 14% fat; 61% moisture and 8% salt. The end product (311 boxes 45% yield) was 38.6% moisture and 11.5% fat. The final product was good but had little smoke penetration. It was shipped to the Dominican Republic. The recycle damper was closed during the trial and the exhaust fan was not put into operation until the last five days.

Trial 3

The third trial commenced September 27 and terminated October 28th 1977 (37 days). The tunnel was loaded with 15,000 pounds of salt herring which produced 321 boxes of bloaters (39% yield). The final product was good (20% standard Bloaters and 80% Choice Bloaters). The bloaters were shipped to the Dominican Republic. During the trial, the air was not recycled and the exhaust fan was operated.

Trial 4

The fourth trial commenced January 13th and terminated February 2nd 1978 (18 1/2 days). The 11,375 pounds of fresh herring (12% fat) were brined for 2 days in a 65% salt solution. The final product (251 boxes at 40% yield) was 38.7% moisture, 13.4% fat; 8.6% salt and 10.7% ash.

The colour of the bloaters was good but the fat and moisture content was a little above the optimum and the salt content was a little below the optimum. Unfortunately there was very little smoke penetration into the flesh of the fish. The end product proved acceptable but the quality of the fish was not desirable.

Trial 5

The fifth trial commenced June 27th and terminated July 13th 1978 (17 days). The tunnel was loaded with 6000 pounds of fresh herring (19% fat). The herring was brined for 4 days in a 100% salt solution. The fish were strung on aluminum and wooden rods. Initially the fish were dried very slowly, heavily smoked and all processing stopped intermittently to allow the moisture to diffuse from the inside to the outside of the fish. (This step was not administered in the trials 1 to 4). This procedure allowed good smoke penetration which was not achieved in the previous trials. The final product (121 boxes, 36% yield) was a very desirable mild cured bloater. The colour, odour, taste, and texture were excellent with 19.4% fat, 11.1% salt and 40.1% moisture. Because of the high fat content, it was not suitable for the West Indies market.

APPENDIX F

Possible Improvements for Bloater Processing

Most existing bloater houses are old and need replacing or alterations. Some possible improvements to the existing bloater houses are;

(a) The use of fans, recirculation air ducts, dampers, temperature and humidity controls could reduce the drying time by increasing the air velocity through the fish and improving the air conditions. Hot air rising through the fish slowly cools and becomes wetter and heavier. The down-draft of wet cool air found in the smokehouse depends upon the number of fires (driving force) and the degree of cooling and evaporation. This down-draft which is a hindrance to drying could be eliminated by a forced upward circulation.

Increasing the velocity decreases the drying-smoking period and also helps eliminate the fly infestation problem.

(b) Add a hoisting mechanism and overhead conveyor to lift and place the loaded rods. It would also be advantageous to leave a space in the middle of the smokehouse, so there would be adequate room to change the rods.

(c) Sawdust consumption may be decreased and heat saved by recirculating smoke through a system of ducts.

(d) Insulation of the smokehouse would decrease wood consumption and costs. A producer from the Shediac area said his insulated smokehouse gives better heat control; less fuel is required and there is more uniform drying from top to bottom.

(e) Construct a sloping concrete floor in the smokehouse to facilitate clearing and to help control insect infestation.

(f) Install screens over all openings such as windows and doors to improve insect control.

(g) Some producers may produce 4 to 5 batches per year, if the smokehouse were heated by oil. The large temperature fluctuations in a conventional wood heated smokehouse during the day and especially in the winter would be reduced with an oil fired furnace and insulated smokehouse.

(h) The existing method for rodding fish could be improved by the use of a fish rodding machine. The rate by hand is 60 sticks/man hour. A $5000 machine can do 300 sticks/man/hour. One machine would be able to service many houses. The machine could be utilized on a cooperative basis.

(i) A smoke generator could be used to reduce labor.

(j) Utilize mechanical sorting equipment to sort fish to sizes, small, medium and large. The smaller fish could be placed at the bottom thus dried and smoked first.

(k) The production of mild cured bloaters could utilize the fattier herring and perhaps open new markets. Although the bloater processors work in a constrained environment which does not permit a great deal of innovation, more research work to produce a mild cured bloater could be carried out. It is more profitable for smokers to produce bloaters from fall and winter herring than from spring herring. The difference is in yield. One barrel of herring (235-250 lbs) gives 3 to 5 1/2 18 lb boxes in the spring. The same amount of herring yields 7-8 boxes during the fall and winter because of the higher fat content. The feasibility of producing mild cured bloaters from frozen herring should be investigated.

(l) Possibly a small number of low cost portable tunnels at approximately $10,000 could be located inside fishing sheds. When not producing bloaters, the tunnels could be used for drying and smoking other fish such as eels, salmon, gaspereau and groundfish.

(m) Other suggestions for modernizing bloater production are; automatic brine makers; folding corrugated carton, plastic/wax coated; automatic packing and closing of boxes; and fluming fish from truck to tank.

APPENDIX G

Problems Associated with the Bloater Industry

Marketing

Most of the bloaters produced are hard cured and the principal export market is the Caribbean. Export prices have increased substantially over the last few years. Presently, the price is approximately $11 per box (16¢/lb).

The marketing of bloaters involves everyone from the fishermen to the ultimate product consumer. There are basically three prices involved, the price the fishermen will receive for their herring; the price the producer will charge for his bloaters and the price the consumer will eventually pay for the bloaters. The

consumer must pay all the additional price increases from the time the herring is landed, to the time the finished product is purchased. All prices are dictated by the law of supply and demand.

Supply of herring is not always available to the bloater producers. At times, producers cannot afford the high cost of herring when it is available. For many reasons, the lack of herring being the major one; the Magdalen Island bloater production is only working at 25% capacity. Four or five years ago, there were 13 bloater producers, operating on Grand Manan; at present there are 10.

Product Quality

All herring are not suitable for producing bloaters. Pre-spawned fish are preferred over spent fish which are thin and do not produce a quality bloater. Mature male fish are not acceptable because the milt deteriorates as it does not absorb the pickle. The fish must be fresh with a low fat content. Excessively large or excessively small fish must not be used. Fish must be scaled and must be free of red feed.

Bloaters and bloater fillets are graded as (a);"choice" which is first quality (properly cured herring that has been smoked to a golden colour) and (b); standard (a properly cured herring whether or not it has taken the smoke properly) is broken at the throat or belly or has other slight defects. As a rule, only the choice grade is exported.

Bloaters are packed in wooden boxes holding 18 lbs net weight and the number of bloaters in each box varies; less than 61; 61 to 80; 81 to 120; 121 to 160 or more than 160. The largest fish in a container of bloaters shall not be more than one inch longer than the shortest fish in the container when measured from the tip of the nose to the round of the tail.

Boxes that are stamped "spring" or just Bloaters indicate low fat fish 12-15%. Boxes stamped "winter" indicate fish with a fat content of 15% and boxes stamped "fall" indicate fish with a fat content of 20-24%.

The Dominican Republic and Haiti prefer small sized bloaters and desire boxes containing a count of 81-120. Jamaica and Puerto Rico require the larger bloaters with a high fat content.

Experiments indicated that bloaters with a high moisture content and a low salt content do not stand up well when exposed to high temperatures and humidities. Bloaters with 36-40% moisture content and salt content of 5-9% did not stand up more than 6-10 days under simulated tropical conditions (85°F and 70-80% relative humidity). Bloaters with moisture contents below 33% and salt content above 10% stand up much better.

Climatological Problems

Sometimes during the summer on Grand Manan, it may take up to 2 months to get 21 days of suitable drying conditions because of fog. In the Cape Bald area, there is considerable time lost in the summer due to high humidity. If the air is too humid, there is the possibility of bloaters absorbing moisture.

Distribution

Bloaters are widely distributed. Approximately 90% of the total exports of bloaters are shipped to the Caribbean. The Dominican Republic purchases over 60% of the overall production.

In the past 4 or 5 years, bloater producers have commenced producing mild cured bloaters. When the demand for bloaters is strong, the market can absorb a certain quantity of mild cured which must be disposed of quickly. Bloater and bloater fillets supply the club trade in Toronto and New York.

Labour

The lack of available labour in this labour intensive industry is a serious problem. Most of the labour is local, composed of students, housewives, and fishermen. In some cases, the processor's family run the entire operation. The work to be performed requires no specialized skills.

The labourers are employed to salt the herring, string them for drying and to hang them for smoking. Smoking is laboursome as the fires must be tended all night. Labourers return to make the boxes at packing time, to unstring the herring after smoking and then to pack them. Full time labour is employed for an average of 12 weeks (that is the period it takes to produce the bloater).

Costs

Bloater production has increased from 4.9 million pounds in 1971 to 8.7 million pounds in 1977. The export value has also risen from $1,215,000 in 1971 to $3,645,000 in 1977.

The greatest contributions to the increase in cost has been raw material and labour costs. These two items rose from 61% of total costs in 1963 to 75% in 1973. Labour costs amount to 34% of total production costs and fuel costs represent 4 to 5% of the total costs.

Family labour can lower labour costs up to 60%. The husband, wife and their children can tend fires, make the boxes, string the fish and pack the fish. Costs are high when a lot of people are hired for short periods of time.

The fish yield (bloaters) is calculated at 40% (40 lbs of end product from 100 lbs of fresh herring). A loss of yield of 1% results in 7¢ loss per box. The bloater operator can minimize his losses by careful supervision and processing and knowing what the moisture content of the product should be for the various markets. Costs could be cut if the conventional wooden box was replaced with a wax coated corrugated cardboard box. This would reduce packaging costs (a saving of approximately 20¢/box) although, one of the advantages of wooden boxes is their ability to absorb moisture and preserve the dryness of the product.

In summary, it should be emphasized that the cost of labor and herring represent a very high proportion of the total cost and efforts should be made to reduce these costs.